CLAIMS

1. A machine vision method comprising:

sensing light energy associated with a scene;

generating color image data representing at least a portion of the scene, wherein the data are arranged as pixels, and the data for a given pixel comprise an intensity value, a hue value, and a chroma value, the intensity value representing the total sensed light energy associated with the pixel, the hue value representing a dominant or average frequency of the light energy associated with the pixel, and the chroma value representing a measure of the light energy on a side of the visible spectrum complementary to the hue.

2. The method of claim 1, wherein the light energy associated with the scene comprises reflections of light from an illumination source at an illumination level, whereby the hue value is substantially invariant to changes in the illumination level.

3. The method of claim 1, wherein the light energy associated with the scene comprises reflections of light from an illumination source having an illumination color, whereby the hue value is, but for a correction factor, the same as under white illumination.

4. The method of claim 1, whereby the hue and intensity values are substantially invariant to changes of each other.

5. The method of claim 1, wherein the sensing step comprises measuring three primary color values; and the generating step comprises converting the three primary color values for the given pixel to a set of values comprising the chroma value, the hue value, and the intensity value.

6. The method of claim 5, wherein the three primary color values are red, green, and blue.

7. The method of claim 6, wherein the red value is denoted *r*, the green value denoted *g*, and the blue value denoted *b*, and the converting step comprises:

determining the intensity value (*I*) in at least approximate accordance with the relation: $I = \sqrt{r^2 + g^2 + b^2}$.

8. The method of claim 7, wherein the converting step further comprises:

determining a quantity (β) in at least approximate accordance with the relation: $\beta = \cos^{-1}\left(\frac{2r - g - b}{2\sqrt{I^2 - rg - rb - bg}}\right)$; and

determining the hue value (*H*) in at least approximate accordance with the relation: $H = \begin{cases} \beta, & g > b \\ 2\pi - \beta, & otherwise \end{cases}$.

9. The method of claim 8, wherein one or more of the determining steps is accomplished by table look-up.

10. The method of claim 7, wherein the converting step further comprises:

determining the chroma value (*C*) in at least approximate accordance with the relation: $C = \cos^{-1}\left(\frac{r + g + b}{\sqrt{3} \cdot I}\right)$.

11. The method of claim 10, wherein one or more of the determining steps is accomplished by table look-up.

12. The method of claim 1 further comprising:

processing the generated color image data.

13. The method of claim 12 further comprising:

after the processing step, converting the chroma, hue, and intensity values to red, green, and blue values.

14. The method of claim 13, wherein the converting step comprises:

determining quantities β, σ, and η in at least approximate accordance with the relations: $\beta = \begin{cases} H, & H \le \pi \\ 2\pi - H, & otherwise \end{cases}$, $\sigma = \cos(C) \cdot \sqrt{3} \cdot I$, and $\eta = \sqrt{6} \cdot I \cdot \cos(\beta) \cdot \sin(C)$;

determining the red value (r) in at least approximate accordance with the relation: $r = \frac{\sigma + \eta}{3}$;

determining the blue value (b) in at least approximate accordance with the relation: $b = \frac{1}{2} \cdot \left[(\sigma - r) \pm \sqrt{2 \cdot I^2 - (\sigma - r)^2 - 2 \cdot r^2} \right]$; and

determining the green value (g) in at least approximate accordance with one or more of the relations: $g = \sigma - r - b = \frac{1}{2} \cdot \left[(\sigma - r) \mp \sqrt{2 \cdot I^2 - (\sigma - r)^2 - 2 \cdot r^2} \right]$.

15. The method of claim 14 further comprising:

determining whether to add or subtract the square root in the relation defining the blue value and the green value, based on the hue value.

16. The method of claim 14, wherein one or more of the determining steps is accomplished by table look-up.

17. The method of claim 14 further comprising:

determining whether the chroma value is legal; and

based on the determining step, conditionally performing the converting step.

18. An image data processing method comprising:

obtaining color image data representing at least a portion of a scene, from which light energy radiates, wherein the data are arranged as pixels, and the data for a given pixel comprise an intensity value, a hue value, and a chroma value, the intensity value representing the total light energy associated with the pixel, the hue value representing a dominant or average frequency of the light energy associated with the pixel, and the chroma value representing a measure of the light energy on a side of the visible spectrum complementary to the hue; and

processing one or more of the chroma, hue, and intensity values.

19. The method of claim 18, wherein the processing step comprises:

compressing one or more of the chroma, hue, and intensity values, whereby the one or more compressed values can be stored, transmitted, or processed more efficiently.

20. The method of claim 19, wherein the compressing step comprises:

quantizing the intensity value; and

quantizing the chroma and hue values;

21. The method of claim 20, wherein the two quantizing steps are performed independently of each other and in parallel.

22. The method of claim 20, wherein the step of quantizing the intensity value results in a quantized intensity value having nine bits or less, and wherein the step of quantizing the chroma and hue values results in quantized chroma and hue values having a total of nine bits or less.

23. The method of claim 18 further comprising at least one step selected from the group consisting of:

transmitting the compressed one or more of the chroma, hue, and intensity values; storing the compressed one or more of the chroma, hue, and intensity values; and further processing the compressed one or more of the chroma, hue, and intensity values.

24. A method comprising:

sensing electromagnetic energy associated with a source over an area in N frequency bands, wherein N > 1; and

generating color image data representing at least a portion of the area, wherein the data are arranged as pixels, and the color data for a given pixel comprise an intensity value, a hue value, and a chroma value, wherein the N frequency bands constitute a mathematical basis in N-dimensional space; wherein one of the N frequency bands establishes a first reference vector in the space, and equal parts of all N frequency bands establish a second reference vector in the space; wherein a plane containing the first reference vector and the second reference vector establish a reference plane in the space; wherein the data for the given pixel corresponds to a point in the N-dimensional space, such that the point corresponding to the data for the given pixel and the second reference vector define a plane of interest, such that the hue value is an angle between the reference plane and the plane of interest, and the chroma value is an angle subtended in the plane of interest between the point corresponding to the data for the given pixel and the second reference vector, and the intensity value is a Euclidean norm of the point corresponding to the data for the given pixel in the space.

25. The method of claim 24, wherein N = 3.

26. The method of claim 25, wherein the three frequency bands lie at least substantially in the visible spectrum and correspond to the primary colors red, green, and blue.

27. The method of claim 26, wherein the red frequency band establishes the first reference vector.

28. The method of claim 24, wherein the source produces electromagnetic energy by reflection of electromagnetic radiation from a separate radiation source, the radiation source having a radiation level, whereby the hue value is substantially invariant to changes in the radiation level.

29. The method of claim 24, wherein the source produces electromagnetic energy by reflection of electromagnetic radiation from a separate radiation source having a dominant radiation frequency, whereby the hue value is, but for a correction factor, the same as under spectrally dispersed radiation.

30. The method of claim 24, whereby the hue and intensity values are substantially invariant to changes of each other.

31. The method of claim 24, further comprising:

performing the generating step for substantially all pixels constituting the color image data.

32. The method of claim 24, further comprising:

performing the generating step for substantially all pixels constituting a contiguous subset of the color image data.

33. The method of claim 25 further comprising:

processing the generated color image data.

34. The method of claim 33, wherein the processing step comprises:

compressing the generated color image data.

35. The method of claim 24, wherein the generating step comprises:

computing a quantity (β) according to the formula: $\beta = \cos^{-1}\left(\frac{N_R \cdot N_C}{|N_R||N_C|}\right)$,

where N_R is a normal vector to the reference plane, and N_C is a normal vector to the plane of interest;

determining the hue value (H) according to the relation:

$$H = \begin{cases} \beta, & \text{if mid-frequency energy} > \text{high-frequency energy} \\ 2\pi - \beta, & \text{otherwise} \end{cases};$$

determining the intensity value (I) according to the formula: $I = \sqrt{\sum_{j=1}^{N} E_{fj}^2}$, wherein the electromagnetic energy sensed in the N frequency bands are denoted $E_{f1}, E_{f2}, \ldots, E_{fN}$, respectively; and

determining the chroma value (C) according to the formula:

$$C = \cos^{-1}\left(\frac{\sum_{j=1}^{N} E_{fj}}{\sqrt{N} I}\right).$$

36. The method of claim 35, wherein N = 3.

37. The method of claim 36, wherein the three frequency bands correspond at least approximately to visible red, green, and blue.

38. A color image data processing method comprising:

obtaining color image data representing at least a portion of the area from which electromagnetic energy emanates in at least N frequency bands, wherein the data are arranged as pixels, and the color data for a given pixel comprise an intensity value, a hue value, and a chroma value, wherein the frequency bands constitute a mathematical basis in N-dimensional space; wherein one of the N frequency bands establishes a first reference vector in the space, and equal parts of all N frequency bands establish a second reference vector in the space; wherein a plane containing the first reference

vector and the second reference vector establish a reference plane in the space; wherein the data for the given pixel corresponds to a point in the N-dimensional space, such that the point corresponding to the data for the given pixel and the second reference vector define a plane of interest, such that the hue value is an angle between the reference plane and the plane of interest, and the chroma value is an angle subtended in the plane of interest between the point corresponding to the data for the given pixel and the second reference vector, and the intensity value is a Euclidean norm of the point corresponding to the data for the given pixel in the space; and

processing one or more of the chroma, hue, and intensity values.

39. The method of claim 38 wherein the processing step comprises:

compressing one or more of the chroma, hue, and intensity values, whereby the one or more compressed values can be stored, transmitted, or further processed more efficiently.

40. The method of claim 39 wherein the compressing step comprises:

quantizing the intensity value; and

quantizing the chroma and hue values;

41. The method of claim 40 wherein the two quantizing steps are performed independently of each other.

42. The method of claim 40 wherein the two quantizing steps are performed in parallel.

43. The method of claim 40 wherein the step of quantizing the intensity value results in a quantized intensity value having nine bits or less.

44. The method of claim 40 wherein the step of quantizing the chroma and hue values results in quantized chroma and hue values having a total of nine bits or less.

45. The method of claim 39 further comprising:

transmitting the compressed one or more of the chroma, hue, and intensity values.

46. The method of claim 39, further comprising:

storing the compressed one or more of the chroma, hue, and intensity values.

47. The method of claim 39, further comprising:

processing the compressed one or more of the chroma, hue, and intensity values.

48. The method of claim 38, wherein the obtaining step comprises:

sensing electromagnetic energy associated with a source over an area; and

generating the color image data on the basis of the results of the sensing step.

49. The method of claim 38, wherein the obtaining step comprises:

receiving a transmission comprising the color image data.

50. The method of claim 38, wherein the obtaining step comprises:

retrieving the color image data from a storage memory.

51. The method of claim 38, wherein the processing step comprises converting the color image data to an RGB format, and the method further comprises:

rendering the color image data in the RGB format on a display.

52. The method of claim 50, wherein N > 3, the color image data represents a hyperspectral image, and the rendered color image data in the RGB format is a false color image.

53. A computer-readable medium on which is embedded computer software, the software performing a method for generating color image date representing at least a portion of a scene, the method comprising:

generating color image data representing at least a portion of the scene, wherein the data are arranged as pixels, and the data for a given pixel comprise an intensity value, a hue value, and a chroma value, the intensity value representing the total light energy associated with the pixel, the hue value representing a dominant or average frequency of the light energy associated with the pixel, and the chroma value representing a measure of the light energy on a side of the visible spectrum complementary to the hue.

54. A computer-readable medium on which is embedded computer software, the software performing a method for generating color image date representing at least a portion of an area from which electromagnetic energy emanates, the method comprising:

generating color image data representing at least a portion of the area, wherein the data are arranged as pixels, and the color data for a given pixel comprise an intensity value, a hue value, and a chroma value, wherein the N frequency bands constitute a mathematical basis in N-dimensional space; wherein one of the N frequency bands establishes a first reference vector in the space, and equal parts of all N frequency bands establish a second reference vector in the space; wherein a plane containing the first reference vector and the second reference vector establish a reference plane in the space; wherein the data for the given pixel corresponds to a point in the N-dimensional space, such that the point corresponding to the data for the given pixel and the second reference vector define a plane of interest, such that the hue value is an angle between the reference plane and the plane of interest, and the chroma value is an angle subtended in the plane of interest between

the point corresponding to the data for the given pixel and the second reference vector, and the intensity value is a Euclidean norm of the point corresponding to the data for the given pixel in the space.